The pedagogical role of language in science teaching and learning in South Africa: a review of research 1990-2015

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Abstract

One of the objectives of the South African science curriculum is to provide equal access to science for students from all backgrounds. However, this goal remains elusive as many students, particularly those from low socio-economic backgrounds continue to perform poorly in science. One of the reasons for the persistent differential achievement in science is language. Yet, the latest review of research in science education in South Africa conducted in 2009 identified only five papers focusing on language in science in the key journals reviewed. This paper presents a review of literature on language in science, with specific focus on research on the pedagogical functions of language in South African science classrooms in the past three decades. We extended the scope of the review by looking beyond the key journals considered in the 2009 review to include any other journal publications on language in science. Analysis of the research itself suggests that earlier studies focused on ways to resolve a perceived language crisis in ESLs classrooms. There is a shift in focus with more recent research exploring the mobilisation of the linguistic resources of the classroom for learner conceptual engagement. We discuss these emerging trends.

Key words: pedagogical role, communicative practices, home language, code-switching, CLIL

Introduction

One of the objectives of the South African science curriculum is to provide equal access to science for students from all backgrounds (DoE, 2011). However, this goal remains elusive as many students, particularly those from low socio-economic backgrounds continue to perform poorly in science. One of the reasons for the persistent differential achievement in science is language (see for example Brock-Utne, 2007; Howie, 1997 Howie, Scherman & Venter, 2008; Reddy, Prinsloo, Arends, Visser, Winnaar, Feza, & Ngema, 2012).

The majority of South African teachers and learners are not first speakers of English, the preferred language of learning and teaching (LOLT) (Evans & Cleghorn, 2012). Thus, science teaching and learning happens in a language that most are not proficient in. While this is true of many science classrooms globally, the situation in South Africa is compounded by the fact that many science classrooms are also multilingual. That is, it is not uncommon to have more than one local language represented in any science classroom at a time. Furthermore, most South Africans are themselves multilingual, with many speaking more than one local language. Thus, for most South African learners and teachers English is a third or fourth language (Adler, 1997). This has implications not only where English is the preferred LOLT but also in cases where there may be a desire to use a local language as the

LOLT. Hence, the importance of understanding the curricular and pedagogical considerations that can enable access to science for all.

Most of what is known about language in the teaching and learning of content subjects in South Africa is from research in mathematics classrooms (see Venkat, Adler, Rollnick, Setati, & Vhurumuku, 2009). Very little is known about research conducted in science classrooms about language, both in terms of actual numbers of published research and qualitatively in terms of focus and findings of such research. Past literature reviews have turned up only a few studies of language in science education. We found three such reviews, two on science education research in general and one focusing on language in science education. In a general review of science education research, Malcolm and Alant (2004) noted that there was much more extensive research on language in mathematics classrooms than there was in science classrooms. The same observation was made in a subsequent review of mathematics and science education research by Venkat et al. (2009), which turned up only five papers in the journals reviewed. In the same journal issue, Lerman (2009) identified language in mathematics and science education as an area needing further research. In an earlier review, Rollnick (2000) also noted the scarcity of research on ESLs' experiences of learning science in the English language. All three reviews highlighted gaps in available knowledge and understanding of language issues in science teaching and learning. It has been eight years since the publication of the Venkat et al. (2009) review of science education research and 17 since Rollnick's (2000) review of research on language in science. A follow up review seems due, in order to illuminate the findings of any research that has since been conducted on language in science in South Africa as well as highlight the findings of previous research in the context of current developments in science teaching and learning. Literature points to increasing awareness of language issues in South African classrooms and the need for research informed interventions in the teaching and learning of science at school level and particularly in teacher education (Lerman 2009). Furthermore, according to Evans and Cleghorn (2014) parental attitudes to language in the classroom may be changing. Data from a questionnaire on the language preferences of non-English speaking parents of young primary school children show that "many parents favour an approach that also nurtures the home language, even while support for an English-only approach is strong. It may be that well-established research findings on the pedagogical and social benefits of maintaining home/local languages are being heard, at least among younger and better educated parents" (p. 1). This together with international trends in language in science research has implications for the teaching and learning of science in South Africa's increasingly linguistically and culturally diverse science classrooms.

This study is part of a review process that aims to identify studies reporting research on language in science teaching and learning in South Africa as well as articulate what is known and what still needs to be understood about language in science. This paper addresses three questions relating to the pedagogical role of language in science:

> *a) What research has been conducted in South Africa on the pedagogical role of language in the teaching and learning of science?*
> *b) What pedagogical role of language can be deduced from this research and what are the implications for language practices in science classrooms?*

The focus of the review and selection criteria for inclusion and exclusion

Language research is diverse both in focus and findings. According to Badger, Nursten, Williams and Woodward (2000) it is important to make explicit the focus of a review as well as the selection criteria for inclusion and exclusion of studies in the review. In this case, the criteria for selection of research to include or exclude from the review was based on the question, what counts as research on the pedagogical role of language in science? What research would fit into this broad topic? In the next section we discuss how we resolved these questions and how the answers informed our methodology for the review.

Defining the pedagogical focus

While it can be argued that teaching is not necessary for learning to happen, it is true that the quality of learning is dependant among other things on the quality of teaching. For Farquhar (2003, p. 5) quality teaching is defined by "pedagogical practices that facilitate for diverse children their access to knowledge, activities and opportunities to advance their skills in ways that build on previous learning, assist in learning how to learn". Thus, specific pedagogical practices afford learner access to knowledge. According to Siraj-Blatchford, Sylva, Muttock, Gilden and Bell (2002, p. 10) teacher pedagogical practices include "... the instructional techniques and strategies that allow learning to take place … refers to the interactive process between teacher/practitioner and learner". It is what happens on a day to day basis in the classroom that determines learner access to knowledge; creating opportunities for learning to happen, facilitating leaner engagement with the subject matter. Operationalising the description of pedagogical practices by Siraj-Blatchford et al. (2002), we determined that a pedagogical focus should involve an understanding of the diversity of learners, of the learning of science as well as appropriate methods, practices and activities to mediate the learning. Thus, pedagogical use of language included all planned (intended) or unplanned (spontaneous) uses of language for creating and managing a conducive learning environment. This includes:

- Being aware of the language resources in the classroom
- Anticipating and planning for the language diversity in the classroom
- Identifying appropriate teaching strategies and communicative practices
- Mobilising language resources to facilitate learner engagement with the subject matter

Our interpretation of the review data was informed by this understanding of a pedagogical focus in teaching science.

Methodology

The bigger review searched for literature reporting research that either targeted or referred to language in the teaching and learning of science. To keep the scope of this paper manageable as well as focus the review on research that has been subjected to peer review processes, only research published in peer reviewed journals was targeted, thus excluding books, book chapters, conference proceedings and student research in dissertations and theses. This would be research that is available in the most accessible forms for the science education community.

While the most recent review focused on key local and international journals in which South African researchers in science education publish their work (Venkat et al., 2009), we extended the scope of the review by looking beyond the key journals to include other journal publications on language in science. From our initial searches, we found the earliest papers on language in science to have been published in 1990. We then examined all available issues

of the selected target journals from 1990-2015. A detailed description of the methodology is given in an upcoming paper reporting the overall review.

Data analysis and findings

We found 27 papers reporting on the pedagogical role of language in science. We then did a frequency count of references to each of the specific language focus areas in the research reported in each paper (Table 1). This was followed by thematic analysis of the papers' findings and recommendations. We present our findings according to the three guiding questions.

What research has been conducted in South Africa on the pedagogical role of language?

The exact language focus of the papers was determined by identifying the language form that was targeted in the study: whether home language (HL), English as a language of learning and teaching (LOLT), code switching (CS), the language of science (LoSci), or other focus (see Table 1).. The language focus of the research was clear in most papers. However, some papers reported findings relating to several categories. For instance, a paper focusing on development of learner academic literacy might also yield findings relating to code switching, mobilisation of HLs, English as the LOLT and/or learner experiences of the language of science.

Table 1. Number of papers referencing each focus area of the pedagogical role of language in science teaching and learning (not mutually exclusive)

	Literacy	**English as the LOLT**	**Code switching CS**	**Mobilising HLs**	**Learner experiences of language of science**	
					For conceptual engagement	**Developing literacy**
No. of papers	6	11	8	5	5	6

Research on the role of language in pedagogy is dominated by studies focusing on the LOLT - whether the English language, code switching (CS) or home languages (HLs) – reported in eleven, eight and five papers respectively, a total of 25 papers. A few papers reported on learner use of language for conceptual engagement or its use to develop ESLs literacies – academic literacy and/or scientific literacy.

Until about 2006, code switching dominated research on language in science generally. Then there was a focus on the role of language in development of learner literacy as well as the role of language in assessment. In the past four years studies have started appearing with a focus on the role of home languages in science teaching and learning. Research published in the last three years of the review period now includes an interest in the dynamics of learner use of their home languages for conceptual engagement and meaning-making.

There were also some studies that could not be clearly categorised into the focus areas listed above. For example, studies in tertiary contexts focusing on ESL teaching and learning in specific disciplines (see Downs, Drummond, Akhurst, & Inglis, 2001; Woollacott, Simelane

& Inglis, 2011; Dempster & Stears, 2013; Linder, Airey, Mayaba, & Webb, 2014). These studies did not have a language research focus, but either targeted an ESL sample or yielded findings relating to language in science classrooms.

What pedagogical role of language can be deduced from this research and what are the implications for language practices in science classrooms?

To determine which aspect of language the research targeted and what can be inferred from the findings of the study about the pedagogical role of language we conducted an inductive analysis of the research. Some cross cutting themes emerged from the data. Most of the papers reported research on the role of language in classroom interaction. This category includes studies looking at the challenges of classroom social interaction in a second language, including mobilisation of HLs for ease of interaction. Then there were studies looking at pedagogical practices that aimed to develop learner literacy (academic literacy with or without scientific literacy). In the third category was research looking at the use of language in the meaning-making processes of science teaching and learning, focusing on mobilisation of linguistic resources of the classroom for ESLs cognitive engagement. Finally, there was also a group of papers reporting research on language in assessment, which for the most part involved analysis of quantitative data on student performance in local and international tests. Due to the limitation of space, the last small cluster of papers will not be reviewed further.

The role of language in facilitating social interaction in ESL science classrooms

The first category includes research on the use of multiple pedagogical strategies, not necessarily because they promote science conceptual engagement but to facilitate social interaction in ESL science classrooms. For example, teaching can draw on the language resources in the classroom to promote motivation, participation or talk by ESLs who would otherwise be unable to do so with English as the LOLT.

Studies in this category focused on the challenges for ESLs teaching and learning science in English. For most of these studies English was the assumed default LOLT, based on either the researchers' knowledge of existing school policies – school choice of English as the LOLT – or beliefs that science should be taught or learned in the English language. Thus, the goal of research was to find ways to help ESLs cope with the challenge of teaching or learning using English, a language most were not proficient in.

The papers identified in this category were published between 2000 and 2006, mostly by Rollnick and colleagues (Cleghorn & Rollnick, 2002; Rollnick, 2000) as well as by Probyn and colleagues (Probyn, 2001, 2006, 2009; Probyn et al., 2002). It is important to point out that these two sets of research were conducted in different linguistic contexts. The Probyn studies were conducted in the Eastern Cape Province where teachers and learners who share the same home language, isiXhosa, teach and learn science in English. This is therefore, a largely bilingual teaching and learning context. The Rollnick studies report research conducted in Gauteng Province, which is a much more cosmopolitan context where most teachers and learners are individually multilingual and science classrooms are multilingual.

The Rollnick papers report research relating to ESLs transitioning between high school and tertiary science education. In the first paper (Rollnick, 2000) she addresses the differences between the challenges faced by learners of English as a Foreign Language (EFLs) and those

of ESLs learning science in English. Different strategies are used to help each of the two categories of learners. In the case of EFLs strategies involve immersion in English in school and outside school as they mingle within their new English speaking communities. For ESLs who do not get immersed and most of whom only encounter English at school, Rollnick suggested the use of multiple strategies that promote hands on practice of science and overt introduction to the genres characteristic of the discipline. In a subsequent paper on the language policy and teacher education Cleghorn and Rollnick (2002) argued that language could be used in the teaching and learning contexts in ways that motivate ESLs to learn English and therefore the need for research to identify the full potential of code switching to help teachers to use it purposefully.

Probyn's earlier papers provide empirical evidence for code switching and its practice by Xhosa speaking secondary school science teachers of Xhosa speaking learners, teaching science in the English language. The 2006 paper reported observations of how effective teachers used a range of teaching strategies, carefully selected according to the teachers' nuanced understandings of their learners' language competencies. The teachers were able to maintain a balance between developing proficiency in language and content in the classroom while maintaining a high level of engagement and without reducing the cognitive demand of the tasks. Probyn like Rollnick recommends cross disciplinary programmes of teacher education, combining science and literacy training to equip teachers with the requisite skills to be able to maintain such a balance. The skill set includes teacher questioning, effective use of the chalkboard for making explicit both the content and the language, teacher understanding of the importance of language and learner talk for conceptual understanding. Once again, the goal is to equip teachers with strategies for developing learner proficiency in English as the LOLT, specifically development and support of learner academic literacy through reading and writing and through cognitively challenging lessons. Probyn suggests that teacher centred rather than open pedagogies may be better for learners in these contexts.

Probyn consistently makes the link between pedagogical and policy issues. She points out the misalignment between school policies about the LOLT and the national Language-in-education policy's (LiEP) intentions to promote bilingualism. In her 2009 paper, for instance, Probyn argues that in spite of national policy and local school regulations for the use of English as the LOLT, teachers and learners (prefer) code switching much more often than is reported. She argues that attitudes towards code switching affect codeswitching practices which then tend to be covert in the classroom, hence the expression, smuggling the vernacular into the classroom (Probyn, 2009). This not only affects language practices during the course of teaching and learning but it also affects classroom-based research as teachers may adopt different linguistic practices when observed. Thus, Probyn argues that the increasing recognition of the role of language in learning is not matched by acknowledgement of this role, especially in school language policies and teacher education. Probyn argues that for many South African learners, language is a social justice issue.

Although Probyn provides a comprehensive list of skills that teacher education should develop in teachers in order to prepare them for the linguistic contexts that they will teach in, she does not suggest a model for teacher education to adopt. In the next section we look at research that focuses on the development of ESLs' literacies and some studies that suggest adopting specific methodologies for teacher education.

Research on the use of language to develop learner literacies in science classrooms

A number of papers reported studies that focus on or reference the deliberate mobilisation of linguistic resources, both HLs and the English language for development of learner literacies. For most of these studies the aim was usually to develop learner proficiency in English as the preferred LOLT. However, there were a few papers that reported research that attempted to combine ESLs development of academic literacy with specific disciplinary literacy. The former group looked at systematic or planned code switching or the use of multiple modes of language development such as writing, reading or talking and listening skills in order to facilitate access to science in the English language (Rutherford & Nkopodi, 1990; Clerghorn & Rollnick, 2002; Inglis, Kirkwood, Downs, & Parkinson, 2007; Webb, 2009; Mayaba, Otterup & Webb, 2013; Linder, Airey, Mayaba & Webb, 2014). The latter group of studies includes those that borrow theoretically and/or methodologically from research in language education to inform ESLs development of scientific literacy and those that advocate the use of international models like CLIL, the Content and Language Integrated Learning model.

We refer first to Cleghorn and Rollnick's (2002) study mentioned earlier with regard to code switching. We refer to this paper at the beginning of this section for two reasons. The first is that the paper does make reference to development of learner literacy. The second and for us a more important reason is how this paper illustrates a recurring dichotomy in the language in science debates that are emerging from the literature reviewed so far. The authors argue that science teachers need to be empowered to motivate learners to learn English, the LOLT. At the same time, they recommend research to "identify the full potential of code switching and categorize its functions so that teachers may be helped to use it purposefully" (Cleghorn & Rollnick, 2002, p. 348). Thus, on the one hand the study argues for code switching as a resource for constructing meaning in classrooms where teachers and learners can use the same home or local language while on the other there is a suggestion for increased motivation to learn English through the establishment of meaningful learning contexts. This dichotomy recurs in the literature that we reviewed and seems to divide debates and the positionalities of researchers, academics, teachers, students, parents and politicians on issues of language in science.

There was research emanating from the Eastern Cape by Webb and colleagues focussing on development of learner literacy. The first paper was a combination of a review of research on discussion, writing, and argumentation with empirical data on a proposed methodology for integrating academic and scientific literacy for ESLs (Webb, 2009). The aim of the integrated learning strategies approach was to develop learner discussion, argumentation and writing skills as well as learner skills for conducting investigations, including formulation of their own questions, planning and executing the investigation and presenting their findings to authentic audiences. The study reported positive findings on the effect of the strategy in terms of development of learner general literacy skills, both in their home language, isiXhosa, and in English as the LOLT. Once again, the study was premised on the assumption of English as the preferred LOLT.

In a subsequent study Mayaba, Otterup and Webb (2013) compared literacy development for ESLs in the Eastern Cape and in Swedish classrooms through the medium of writing. The main thrust of the study was that writing is an important skill in learning science but that it is not easy for children who learn in a second language to acquire the skill. The learners in both countries were taught in a second language. In the South African study, the learners were isiXhosa speaking while in Sweden they spoke a variety of languages. Using classroom observations, teacher interviews and samples of learners work the authors analysed the texts produced by Grade 6 science learners and examined how learners were assisted to produce

them. They observed that while learners were writing, there was no explicit teaching or support for the writing. Teachers said in the interviews that they did not know how different text types could be used to improve learners' writing. While there was evidence of classroom talk, there was no awareness of the importance of talk for developing written text, that talk could be used to help learners frame their writing. The study concluded that science teachers and their learners need to be assisted in developing the skill of writing to learn science.

The Mayaba et al. (2013) study raises a key question about what research findings suggest for teacher education. For teachers working with ESLs the task would involve helping learners transition from oral engagement, whether in English or in the HLs to writing in the English language. This is no easy task as science teachers are not traditionally trained to do this kind of literacy work. In essence this is a call for teacher education to consider some major and radical interventions in teacher professional development. However, there seems to be a crucial step before the Mayaba et al. (2013) study's recommendations to use talk to guide writing. In an earlier study, Setati, Adler, Reed and Bapoo (2002, p. 147) observed that "learning from talk is significantly limited if it is not supported or complemented by strategies for learning to talk, in other words, learning subject specific formal discourses". So, talk in itself is not a useful tool if it is not properly structured and mediated. However, if teachers are unable to help learners learn to talk, they will struggle to use talk texts to support learning to write and writing to learn. Once again this calls for unconventional methods in teacher education as they are not traditionally designed to equip science teachers to be able to mediate talk in the ways suggested by Setati et al. (2002).

In a study in Gauteng province, Ferreira (2011) conducted focus group interviews with Life Science teachers to identify the teaching strategies that they used to assist ESLs. Teachers indicated that they used a variety of strategies including code switching, analogies and experimental work. However, according to Ferreira, "although code switching can help with exploratory talk, teachers have to help learners communicate in English and learners need to practise their language skills orally and in writing". Thus while the potential of HLs as a resource in science teaching and learning is acknowledged there is a strong argument for development of learner proficiency in the English language as the LOLT. Ferreira (2011) suggests Content and Language Integrated Learning (CLIL) as a possible model for teaching and learning subject specific formal discourses and calls for research to investigate its use in the South African context.

Ferreira's suggestion for the use of CLIL approach in the Gauteng Province multilingual context is interesting for two reasons. In CLIL the second language is used as a tool in the learning of science content such that the pedagogical focus is on both the language and the science. According to Coyle (2007, p. 548) "learning how to learn through the foreign language is fundamental to CLIL". Thus, one of the aims as in the studies discussed earlier, is learner proficiency in English as the LOLT. However, the CLIL methodology promises simultaneous content learning. Citing Cummins (2000) work in some Canadian classrooms, Coyle (2007) cautions about the weaknesses of the CLIL model, one of which is that it tends to be teacher-centred or transmission-oriented. Similar observations in European classrooms suggest that in some contexts teacher concerns about time led to transmission-oriented approaches in CLIL teaching resulting in a teacher focus on content delivery. The corollary was that due to the high influence of language acquisition theories on CLIL, pedagogies in some European classrooms tended to favour language teaching. According to Coyle (2007, p. 552) "CLIL demands a reconceptualisation of the role of language in CLIL settings from language learning per se (based on grammatical progression) towards an approach which

combines learning to use language and using language to learn". Clearly implementation of CLIL pedagogies is not straight forward, particularly in linguistically diverse learning contexts as is the case in Europe. This speaks to Probyn's observations in Eastern Cape classrooms on the difficulties that the teachers faced when trying to find a balance between language and content teaching (Probyn, 2006).

Research on the mobilisation of language for cognitive engagement

In this section we look at papers reporting research on the cognitive use of language or the use of language for thinking and engagement with the content, whether this happens in the English language, home languages or through code switching. This is research with a meaning making focus, the use of language resources in the science classroom in mediation of science learning and learner conceptual understanding. However, research studies hardly ever have a single focus. Thus, most of the papers included in this category report findings on the role of language in both the social interaction of the classroom and for cognitive engagement.

An example of research reporting the role of language both in social interaction and for cognitive engagement is a study on teacher communicative practices in ESL classrooms. The study by Jawahar and Dempster (2013, p. 1425), looked at both "the sociocultural view of science as a language" and "some quantitative language features …. to analyse the utterances of three South African Physical Sciences teachers". They characterised teacher utterances "in language contexts characterised by varying proportions of English Second Language (ESL) students in each class" (p. 1425). The authors observed that teachers tended to repeat science content words a lot more in classrooms with higher proportions of ESL students. However, the "lexical density of their utterances did not decrease with an increasing proportion of ESL students". In other words, teachers did not adapt the language difficulty or sophistication for non-speakers of English, which would render the text more challenging for ESLs. Once again the authors call for science teacher education to structure training programmes to equip teachers with knowledge and skills to work appropriately with language in different language contexts. As in the literacy development studies discussed earlier the goal is development of learner proficiency in English as the LOLT as well as acquisition of the language of science.

In a study focusing on learner use of their linguistic resources, Msimanga and Lelliott (2014) observed how learners used their home languages during small group discussions both for ease of interaction and for meaning making purposes. The study highlights the potential of HLs for engagement with difficult concepts and how HLs "may be a legitimate resource for science teachers to create opportunities for learner conceptual understanding" (p. 1180). The study also refers to teacher education as the key to empowering teachers with the requisite teaching strategies to achieve this and for teacher educators to be able to model these strategies. Research to understand the dynamics of such teacher and learner use of HLs in science classrooms could inform these proposed innovations for teacher education. Some of these strategies have already been identified and are reported in literature. Probyn's (2015) study on pedagogical translanguaging as a means of creating bridging discourses in science classrooms is a good example.

In this paper Probyn (2015) looks at how science teachers utilised the linguistic resources of the classroom, both the learners' home language and English and how these practices might improve learners' opportunity to learn science. The author observed one teacher's use of learners' HLs to create a "bridging discourse across modes, discourses and languages" (p220). What distinguished this teacher's practice from that of the other teachers was his

systematic and purposeful use of the learners' home language in what Probyn terms 'pedagogical translanguaging'. Probyn argues that this strategy provided learners with "what appeared to be improved opportunities to learn science as opposed to brief and reactive code-switching or complete avoidance of the learners' home language evident in the other classrooms" (p. 220). It is important to note that this teacher seems to be an exception among the 20 in Probyn's study. This suggests that while some experienced science teachers like this one may be able to work with language in such sophisticated ways, most science teachers require assistance and training to be able to achieve this.

Concluding remarks

Most of the research reviewed focussed on the role of language in classroom interaction, as the LOLT - whether the English language or home languages or code switching. There was also research on development of learner literacy and learner use of language for conceptual engagement.

From the analysis of the findings of the 27 papers reporting research on the pedagogical role of language in science it became clear that there is an implicit debate going on in the science education research community. On the one hand, there are questions about the potential of HLs as a resource to help ESLs engage with difficult science concepts. On the other hand, there is the question of whether the use of HLs both as a coping strategy and as a tool for engaging with difficult concepts may hinder the development of science ESLs' proficiency in the English language. The latter group's concerns centre on the need for learner proficiency in English as the LOLT, as the language of assessment and/or as the language of social and economic engagement locally and globally. We believe this is an important contribution to current understanding of issues about language in science teaching and to the research agenda on the implications of mobilising (or not) learners' HLs in the teaching and learning of science in multilingual classrooms generally and in South Africa in particular.

The suggestion in some of the literature for adoption of the CLIL model in South Africa has not previously been flagged. The CLIL model has been used extensively internationally in bilingual classrooms mostly with immigrant learners who are learning the language of the host country which is usually also the LOLT. The main difference between these international contexts is that the ESLs are invariably immersed in the L2 while in South Africa and most of Africa, the ESLs are as it were immersed in L1 while trying to learn L2, English as the LOLT. The fact that as observed in literature (South) African ESLs do not speak English outside of the classroom presents a new contextual challenge for the CLIL model. Thus, interventions adopting the CLIL model would have to be matched with a specific research agenda to determine its potential and efficacy in the South African linguistic context.

According to the findings of the research reviewed more research is required on the role of language in science at all levels in all teaching and learning contexts; research on the potential of home languages and the dynamics of code switching; teacher education programmes that can equip teachers with the requisite skills to mobilise the language resources in the classroom to afford ESLs access to science; research on language and learning, that is, the dynamics of learner transition from home language conceptual engagement and sense-making to articulation of these understandings in the English language as the language of high stakes examinations. There is also need for studies on the strategies that teacher educators in tertiary institutions and other teacher professional development programmes employ in preparing science teachers for multilingual classrooms. While

anecdotal evidence suggests that some South African universities do have such programmes in place, the absence of research reports on such programmes is significant. Such reports would articulate any existing programmes findings or suggest future research on the potential of all languages (HLs and English) as a teaching and learning resource; appropriate models for development of learner (and teacher) language proficiency (English and HL) and other academic literacy skills; research-informed teaching strategies, including empirical evidence for the potential of CLIL pedagogies.

The integration of ESLs in former Model C schools and increased access to tertiary science have changed the linguistic contexts for science teaching and learning in ways that have not been previously researched. Model C schools are government schools that are administered and largely funded by a governing body of parents and alumni. While they have retained the name "Model C" from the apartheid era, enrolment is no longer segregated. Thus most have a racially and culturally diverse learner and/or teacher population. Meanwhile, the benefits of this diversity are lost in the lack of understanding of the linguistic dynamics in such teaching and learning contexts.

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